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AUTHOR(S) – R.E. McGaughy

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ABSTRACT

As part of a general study of on-board operations on a long-duration, multi-disciplinary space station, this paper develops nominal requirements in the assessment of physiological adaptation and performance capabilities of man in the space environment. The general types of medical and behavioral experiment activities required to accomplish this assessment are described here in terms compatible with activities of other scientific disciplines in the space station. A block of time in the crew's daily schedule has been defined for medical/behavioral measurement activity, and several modes of activity are defined, each mode requiring its own amount of crew time and spacecraft resources.

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SUBJECT: Biomedicine Subsequence in a Multi-Disciplinary Earth Orbital Space Station. Case 720.

DATE: December 27, 1968

FROM: R. E. McGaughy

TECHNICAL MEMORANDUM

I. INTRODUCTION

This memorandum discusses the biomedical and behavioral measurement activity which might be carried out on a six-man, two-year earth-orbital space station whose general characteristics are outlined in a previous memorandum by G. T. Orrok (Ref. 1). Major emphasis is placed on the general types of medical activity which would be meaningful in the space station rather than a detailed description of each crew member's activity throughout the mission.

It will be shown that after the medical experiments are performed enough time remains in the work schedule of each crew member to carry out a reasonable program of astronomy, earth looking and bioscience activities, as well as the personal maintenance and spacecraft operations and maintenance activities in the space station. All of the scientific activities to be conducted on the space station are bounded by the sleep-eat-work schedule described by S. L. Penn (Ref. 2) and referred to as the Personal Maintenance Subsequence.

Since the medical experiment program is very sensitive to previous flight activity, the following assumptions should be kept clearly in mind:

1. Before this two-year multi-disciplinary mission is flown, the AAP program will have been successfully completed. This means that three-man crews will have performed well under close medical surveillance for as long as sixty days without evidence of medical or behavioral problems serious enough to potentially jeopardize crew safety for this mission.

2. The logistics re-supply interval on this flight is assumed to be ninety days. Therefore, even if the astronauts stay up for only one logistics cycle, they will have exceeded their previous stay in orbit by at least thirty days.

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Rationale for Medical Experiments

The experiments are designed primarily to give advanced warning of any impending behavioral or physiological problems which might arise from the stresses of space flight and to predict how well the men are likely to survive re-entry and post-flight earth gravity conditions. In addition to this compelling and immediate objective, in-depth medical experiments are also needed to investigate the time course of man's physiological adaptation between zero-gravity and earth-gravity conditions (including individual variations in this adaptation process) and to test any promising schemes which might be devised to assist us in this adaptation process. It is important to remember that the astronaut population will be among the best medically-characterized group of "normal" people in the world, so that our knowledge of human biology will greatly benefit from carefully-designed studies of astronaut performance under space flight stresses.

II. DESCRIPTION OF MEDICAL ACTIVITY

It is improper at this time to outline the detailed set of medical experiments which should be flown in a 1974 two-year mission because of our lack of experience in long-duration space flight. Instead, we attempt to describe the type of medical experiment activity which will probably be needed to satisfy the objectives of the program, the general types of skills and tasks required of the astronauts, the likely frequency of medical measurements, the factors which affect this frequency and the resulting likely astronaut time required to carry out the measurements.

A. Type of Measurements and Tasks Involved

The medical experiments fall within the following general classes:

1. Laboratory analysis of blood, urine and feces: This provides information about mineral depletion of the astronaut, stress hormones, O_2 carrying capability of the blood, white cell population, water balance, etc. Laboratory analysis of the microbial populations will also be made.

2. Cardiovascular and respiratory measurements: These measurements reveal the dynamics of the blood distribution system (which must function considerably differently in zero-gravity conditions), the heart output, the volume, compliance and functioning of the lungs.

3. Performance measurements: These are designed to keep a running check on sensory perception (including visual and orientation), reaction time, long and short term memory, vestibular function and electro-encephalogram.

4. Metabolic and nutritional studies: These measurements determine the fluid, nitrogen and mineral balance of the astronauts, their metabolic efficiency at performing various known tasks and their work capacity suited and unsuited.

The above experiments will require each astronaut to be the subject of a scheduled set of medical tests. Some of the tests (e.g., performing exercise while wearing electrodes) require that an observer help monitor the measurement recording while the subject is performing the experiment. In addition to being subject and observer, one or more of the astronauts must also have the laboratory technician skills needed to perform analysis on the samples.

To carry out these measurements, the men will definitely have to be trained, but the degree of specialization is low enough that any astronaut could do the job. Anyone who can fly and land a military jet plane could easily learn to conduct these medical experiments. Therefore, for the medical experiments, all crew members are considered interchangeable. The analysis of samples, however, might involve some specialized techniques (such as interpreting white blood cell count). This is the only part of the medical program which cannot be shared by all crew members, but the frequency and duration of these specialized tasks is low enough not to seriously tie up any one man for a significant fraction of his work day.

B. Frequency of Measurements and Time Needed to Perform Them

The preliminary studies of an Integrated Medical and Behavioral Laboratory Measurement System (IMBLMS), which have been conducted by General Electric and Lockheed for NASA Headquarters, outline the measurements which would be feasible and advisable for earth orbiting space station. Some of these measurements are described in Table I. The time needed for each experiment and the frequency of the experiments listed in the IMBLMS studies are in substantial agreement with the "Biolabs" study by Lockheed (Ref. 3).

Since the lists are, in this author's opinion, very complete and call for experiments quite often, we can assume that they were designed for an intensive "biomedical" mission.

If these experiments were all done at their recommended frequency, each astronaut would be the subject of a medical experiment for over 2.5 hours per day and an observer for one hour per day. In addition, analyzing the medical samples for three crew members would take about 3.3 hours per day.

To construct the skeleton of a reasonable medical program for this two-year, six-man, multi-disciplinary space station, we assume for planning purposes that the IMBLMS set of experiments will be run (since we now have no valid way of ruling out problem areas) but that their frequency will be reduced. This is a way of saying that we will undoubtedly know more (therefore need less frequent measurements) about medical problems after the 60-day AAP flights, but we cannot say what we will know. The following table shows how we have reduced the frequency of the medical experiments:

BIOLABS FREQUENCY	REVISED FREQUENCY
Once per 10 days	Once per 14 days
Once per 5 days	Once per 7 days
Every day	Every two days

Using this revised frequency schedule and increasing the laboratory analysis time by a factor of 1.5 to go from a three-man to a six-man crew, we find that the new subject time per astronaut is about 1.75 hours per day, the observer time is about .75 hour per day, and the laboratory analysis time is about 2.5 hours/day. This analysis time could be either split among the three shifts in the day or consolidated into a single block.

Figure 1 shows one way in which this time can fit into the work periods of the personal maintenance schedule discussed by S. L. Penn (Ref. 2). Experiments are performed at a time in the day when four men are available for work, so that if a solar flare or other contingency should arise when medical experiments are in progress, the two remaining crewmen can take care of the contingency without requiring an abrupt cessation in the medical experiments.

It should be pointed out that the average medical experiment time per week for each astronaut adds up to 21 hours in the schedule of Figure 1. This is considerably more time than recommended by the Saturn V Workshop Study (Ref. 4) which allowed a time of 10 to 15 hours per week. It is clear that if 21 hours per week is considered an excessive time to devote to medical experiments, a considerable number of experiments must be removed from the preliminary IMBLMS list of experiments.

C. Effect of Flight Duration on Time Devoted to Medical Experiments

The set of measurements described above and scheduled in Figure 1 is considered a minimum set even for men who have had experience in space before. For example, it calls for most of the measurements to be run every two weeks with only a small amount of time needed for measurements more frequently. Therefore, as the mission progresses to durations longer than the previous experience of the individual astronauts, it may be necessary to increase the frequency of experiments so that any adverse reactions can be predicted before they occur.

This conservative attitude is expressed in spite of the a priori expectation that adaptation to zero-gravity is likely to occur most rapidly when the environment is first altered. If a particular man has had a successful 60-day experience in earth orbit before this mission, we know that he can adapt adequately this far, but we have no experience to guide us in predicting subsequent behavior.

This increase in frequency is advisable not only to protect the individual astronauts on this mission, but also to advance our basic understanding of long-term biological effects of zero-gravity environments before we plan a subsequent manned planetary mission.

Therefore, in the absence of any better plan, it would be logical to increase the frequency of the medical experiments to that recommended by Biolabs when entering phases of the mission when the astronauts are going beyond their previous flight duration. This amounts to a subject time of 2.5 hours/day, an observer time of 1 hour/day and a laboratory analysis time (split among three shifts) of 4.75 hours/day.

Conversely, if medical data on many astronauts indicate that men can work in orbit for a long time (perhaps four to six months) without adverse response, it will be concluded that adaptation to orbital flight is complete. At this time, the frequency of medical experiments will be reduced.

III. BIOMEDICAL SUBSEQUENCE OF ACTIVITIES

Figure 2 describes an over-all view of the medical activities taking place in the space station by listing the general characteristics of several modes, or scheduled activities, of the biomedical/behavioral program. Each mode is characterized by its duration and frequency, who and what systems are participating in the activity, the information flow, spacecraft resources needed to perform that mode, and the factors which will likely necessitate a shift to another mode.

Mode A, the active medical experiment mode, has been discussed in detail above. During Mode B (inactive), medical experiments are not taking place.

Extravehicular activity, described in Mode C, is included in the Biomedical Subsequence rather than the Operations and Maintenance Subsequence because of its attendant medical monitoring. EVA will be necessary in the two-year space station for several reasons. Inspection (either visual or photographic) of the spacecraft exterior might be desirable, although the station will be designed to require a minimum of exterior maintenance. Exterior equipment may need repair or cleaning. Materials might have to be deployed or retrieved if the deployment mechanism fails. Tests of new space suit designs may be needed. In addition to these tasks, each crew member should have EVA experience maneuvering in the extravehicular environment so that he will be able to perform rescue operations in emergencies.

The four-hour time allotment in the chart is obviously not a firm statement of EVA duration, but it does leave about two hours for working at a site after 0.5 hour is allowed for travel to and from the exit port, and 1.5 hours is allowed for EVA preparations (suit donning and doffing, PLSS checkout, equipment storage, etc.). It is assumed that the lifetime of the PLSS equipment is long enough to cover all contingencies.

Mode D (repair of medical equipment) is essentially the same as the repair mode for other equipment (Mode E of the Operations and Maintenance Subsequence), except that here the medical experiments are interrupted and some elementary precautions must be observed before repair is attempted (see Table II).

The normal schedule of medical experiments will be disrupted if one of the crew members needs extra attention for some reason. This is shown in the "transition" section of the "active mode" and the "modified active" mode in the chart. Three possibilities exist: (1) the affected astronaut may need different or more frequent medical tests which could be performed by his "buddy;" (2) the astronaut may need the close attention of the crew medical specialist, and the work-sleep schedule of the entire crew would have to be altered so that the physician becomes his "buddy;" or (3) the incapacitated man may need no attention at all. In severe cases of prolonged duration, it may be desirable to relieve the "buddy" of his medical watch by putting a new man on that shift. In cases more severe than this, one of the abort modes may be required.

IV. SUMMARY

This overall description of the biomedical activities has demonstrated that a meaningful medical measurements program can be accommodated into the daily schedule of a multi-disciplinary space station. For planning purposes we have defined a block of medical time which is adequate for the medical program.

The author wishes to thank S. L. Penn and G.T. Orrok for advice concerning the personal maintenance schedule and B.A. Gropper for helpful comments concerning EVA.

R. E. McGaughy

1011-REM-cb R. E. McGaughy

Attachments
Table I
Figures 1 and 2

REFERENCES

1. Introduction to a Study of Operations on a Multi-Disciplinary Space Station, G.T. Orrok, Bellcomm TM-68-1011-11, December 27, 1968

2. Mission Sequence Plan for a Multi-Disciplinary Earth Orbital Space Station - A Preliminary Report, S.L. Penn, Bellcomm TM-68-1011-9, December 27, 1968

3. Biological Measurement of Man in Space, Vol.VI, Time Line and Feasibility Analysis for AAP Biomedical Experiment Program, CR-62030, Lockheed Missiles and Space Company, January, 1966.

4. Saturn V Workshop Study, Vol. II, Task Team Analysis, OMSF Planning Group, April 1, 1968.

TABLE I

MEDICAL/BEHAVIORAL MEASUREMENT CAPABILITY OF INTEGRATED MEDICAL AND BEHAVIORAL LABORATORY MEASUREMENTS SYSTEM

I. NEUROLOGICAL

- Clinical Evaluation (to include reflexes and sensory and motor pathways)
- Agravic Perception of Personal and Extra-Personal Space (Minimum restraint device)
- Ocular Counter-Rolling
- Oculogyral Illusion
- Visual Task with Head Rotation
- Electronystagmogram
- Angular Acceleration Threshold

(Ocular Counter-Rolling through Angular Acceleration Threshold: To be done with litter-chair)

- EEG

II. CARDIOVASCULAR

- Clinical Evaluation
- ECG (Frank Lead System)
- Phonocardiogram
- Cardiac Output - (By impedance if technique verified; by indicator-dilution if necessary)
- Arterial Blood Pressure
- Venous Pressure - Peripheral
- Blood Volume and Fluid Compartments - See Hematology and Metabolism
- Regional Blood Flow - Limb (or Digit) (Distribution of Blood Volume)
- Venous Compliance
- Arteriolar Reactivity

(Regional Blood Flow through Arteriolar Reactivity: Limb Plethysmography)

- Arterial Pulse Contour
- In-Flight Exercise
- LBNP
- Elastic Leotards

PROVIDE FOR INSTALLATION IF REQUIRED:

- Ballistocardiogram
- Carotid Body Stimulation
- Thoracic Blood Flow
- Venous Pressure - Central (By Catheter if Necessary)

III. RESPIRATORY

- Clinical Evaluation
- Respiratory Rate
- Lung Volumes Including Residual Volume (For total lung capacity, and mixing efficiency)
- Pressure, Flow, and Volume (Simultaneously) (→Airway Resistance)
- Compliance - Lung or Total (Lung if can)
- Distribution of Blood Flow and Gas in Lungs
- Includes: Capillary Blood O_2, CO_2, and pH
  - Breath by Breath O_2 Consumption and CO_2 Production
  - O_2 Consumption - With Measured Exercise
  - Alveolar to Arterial Gradient Breathing Air and 100% Oxygen
- Diffusion Capacity (if suitable technique) (Look into O_2^{18} method - Dr. Richard W. Hyde, U. of Pennsylvania, Dept. of Physiology)

IV. METABOLISM AND NUTRITION

- Clinical Evaluation
- Energy Metabolism (Continuous O_2 and CO_2 Analysis with Breath by Breath Sensitivity) with Various Levels of Activity
- Oral Temperature
- Skin Temperature
- Caloric Intake
- Body Mass In-Flight (Thornton Technique - GFE)†
- [Lean Body Mass Pre- and Post-Flight] - (Not a Part of IMBLMS)
- Muscle Size and Strength
- Balance Studies
  - Fluid, including Sweat
  - Nitrogen (See Area IX)
  - Mineral (See Area IX)
  - Electrolyte (See Area IX)
- Provide for: Accurate Urine Volume Measurement
  - Accurate Wet Weight of Feces
  - Return of Total Dry Stool
  - Accurate Fluid Intake Measurement
  - Return of all Food Packages Marked by Date Time and Individual
  - Sweat Measurement and Sample Return
- Total Body Water (Breatholator or Deuterium)
- * Clinical Laboratory Evaluations - See List Under Area IX

PROVIDE FOR INSTALLATION IF REQUIRED:

- EMG
- Bone Densitometry - Isotope Technique
- Gastric Pressure and pH (Endoradiosonde)
- Plasma Volume On-Board
- Mineral Metabolism by Isotopic Techniques

V. ENDOCRINOLOGY

- Clinical Evaluation
- * Clinical Laboratory Evaluations - See List

VI. HEMATOLOGY

- Clinical Evaluation
- Rumple Leede
- Blood Volume and Fluid Compartment
- Plasma Volume - RHISA
- RBC Mass - DFP^{32} or Cr^{51}
- Total Body Water
- RBC Survival - DFP^{32}
- Clinical Laboratory Evaluations - See List

† Government Furnished Equipment

VII. MICROBIOLOGY AND IMMUNOLOGY

- Clinical Evaluation
- Body Microflora (Bacterial, Viral, and Fungal)
- Environmental Culturing (Bacterial, Viral, and Fungal)
- Clinical Laboratory Evaluations - See List

VIII. BEHAVIORAL EFFECTS

- Clinical Evaluation
- Sensory Test Battery (See Also Neurology)
- Perceptual Evaluation (If validity of Tests Established)
- Higher Thought Processes
- Memory - Short and Long Term
- Vigilance (By measurement of operational tasks)
- Learned Activity (Tracking and Reaction Time)
- Recording of Crew Intercommunication with Automatic Erase in 15 Minutes if not Sampled
- Time and Motion Study

IX. CLINICAL LABORATORY EVALUATIONS

- Creatine and Creatinine - Urinary
- Urinary and Fecal: N, Ca, P, Na, K, Cl, and Mg
- Mucoproteins - Urinary (Pi)*
- Pyrophosphates - Urinary (Pi)
- Hydroxyprolines - Urinary (probably Pi)
- Total Amino Acids - Urinary (Pi)
- Urinary: Osmolality, Color, Sp Gr, pH, Glucose, Protein, Bile, Blood, and Microscopic (i.e., Routine Urinalysis - Inflight)
- Plasma Volume (probably P&P)**
- Electrolytes - Serum
- Total Protein - Plasma
- Glucose - Blood (Inflight)
- Ca and PO_4 - Serum (probably Pi)
- Bilirubin - Serum
- Cholesterol - Serum (probably Pi)
- BUN (probably Pi)
- Uric Acid - Blood (Pi)
- Alkaline Phosphatase - Serum (probably Pi)
- pH, pO_2, and pCO_2 - Blood
- Bicarbonate - Blood
- CPK (Creatine Phosphokinase - Serum (Pi)
- LDH and LDH Isoenzymes - Serum (On-board if have electrophoresis)
- SGOT - Serum
- SGPT - Serum
- Aldosterone - Urine (Pi)
- ADH - Urinary and Serum (Pi)
- ACTH - Blood (Pi)
- Serum Free Thyroxin (T_4 - Serum) (If in-flight, will require thin layer chromatography)
- TBPA (Probably Pi)
- 17-hydroxycorticosteroids - Urine and blood (Pi)
- 17-ketosteroids - Urine (Pi)
- VMA - Urine (Probably Pi)
- Metanephrines - Urine (Pi)
- Catechols - Urine (Pi)
- Histamine - Blood and Urine (Pi)
- 5 Hydroxy Indolacetic acid - Urinary (Probably Pi)
- Blood Cell Morphology (RBC, WBC, and Diff - Smear will suffice for platelets)
- Reticulocyte Count
- Hematocrit
- Hemoglobin
- RBC Fragility (Osmotic)
- RBC Mass and Survival
- Bleeding Time
- Clotting Time
- Prothrombin Consumption
- Clot Retraction
- Lymphocyte Karotyping (Probably Pi)
- WBC Mobilization (Rebuck Technique)
- Immunoglobulins and Fibrinogen
- Transferins
- Hemoglobin
- Methemoglobin

(Immunoglobulins and Fibrinogen through Methemoglobin: onboard if have electrophoresis)

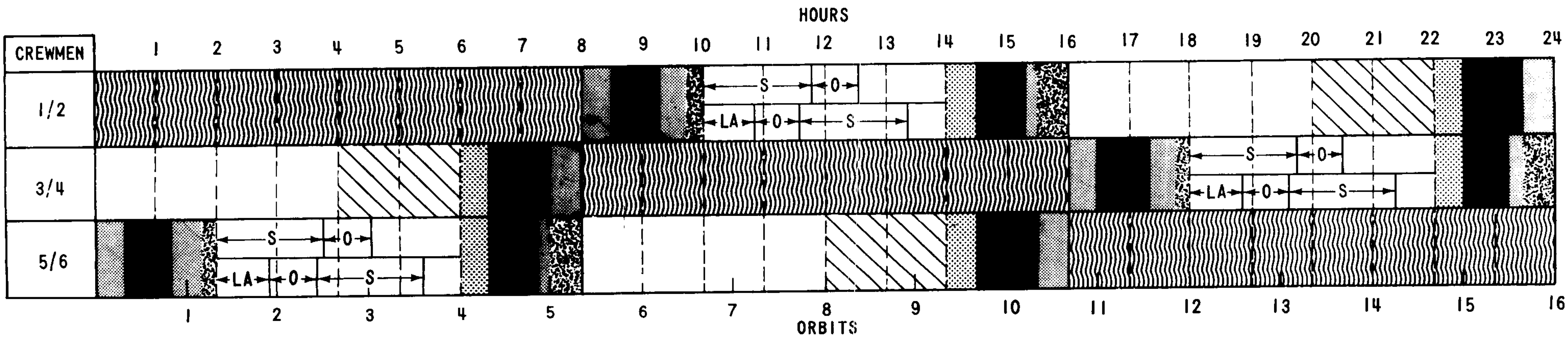
- RBC Enzyme Studies (Pi) (ref. Governing Protocol M110)
- Complement Titration
- Antibody Titration

PROVIDE FOR INCLUSIONS IF REQUIRED:

- Sulfate - Urinary
- TSH (Pi)
- Growth Hormone (Pi)
- Thyroid Bound Globulin (T_3) (Pi)
- Parathyroid Hormone (Radio-immune Technique - Serum) (Pi)
- Parathyroid Hormone - Urinary (Nelson Technique) (Pi)
- Calcitonin - Serum (Pi)
- Insulin Assay (Pi)
- Glucagon Assay (Pi)
- Serotonin (5 HIAA) - Blood (Pi)
- Platelet Adhesiveness
- Fibrinolytic Activity
- Blood Rheology
- Blood Lipids

* Pi - Post-flight evaluation of in-flight samples

** P&P - pre- and post flight



TYPICAL TIMELINE

SLEEP	8 HRS.
HYGIENE	1/2 HRS.
EAT	3/4 HRS.
HYGIENE	1/2 HRS.
HOUSEKEEP	1/4 HRS.
WORK	4 HRS.
EXERCISE	1/2 HRS.
EAT	3/4 HRS.
HYGIENE	1/4 HRS.
HOUSEKEEP	1/2 HRS.
WORK	4 HRS.
REST & RECR.	2 HRS.
EXERCISE	1/2 HRS.
EAT	1 HRS.
HYGIENE	1/2 HRS.
TOTAL	24 HRS.

MEDICAL ACTIVITIES

S	SUBJECT IN EXPERIMENT	1 3/4 HRS.
O	OBSERVER OF EXPERIMENT	3/4 HRS.
LA	LABORATORY ANALYSIS	0.8 HRS.

LEGEND

- SLEEP
- HYGIENE
- EAT
- HOUSEKEEP
- WORK
- EXERCISE
- WORK OR REST & RECR.

FIGURE 1 - CREW PERSONAL MAINTENANCE AND MEDICAL ACTIVITIES SCHEDULE

PROPERTIES / MODES	A. ACTIVE	B. INACTIVE	C. EVA	D. REPAIR	E. MODIFIED ACTIVE
I. TIME : a) DURATION, REPETITIONS USE OF CREW b) CONSTRAINTS	a) EACH MAN IS A SUBJECT FOR 1-3/4 HOURS/DAY (AVERAGE) AND AN OBSERVER FOR 3/4 HOUR/DAY. LAB TECHNICIANS ANALYZE SAMPLES FOR 2-1/2 HOURS/DAY. ANALYSIS TIME CAN BE DIVIDED AMONG THREE SHIFTS b) 1. AVOID STRENOUS EXERCISE WITHIN 2 HOURS FOLLOWING MEALS b) 2. SHOULD BE SCHEDULED WHEN FOUR MEN ARE AVAILABLE FOR WORK (MODE B OF P.M. SUBSEQUENCE.)	14 HOURS/DAY IN 3 PARTS SEPARATED BY THREE MEDICAL WORK PERIODS PER DAY.	a) DURATION IS FOUR HOURS FOR EVA (INCLUDING PREPARATIONS). EACH MAN GOES AT LEAST ONCE, PREFERABLY EARLY IN MISSION. b) AVOID SOUTH ATLANTIC ANOMALY. DEFINITELY LESS THAN ONE EVA/DAY/MAN, PREFERABLY LESS THAN ONCE/WEEK.	a) DURATION AND FREQUENCY SAME AS "OPERATIONS AND MAINTENANCE" CHART b) REMOVE BIOELECTRIC SENSORS BEFORE REPAIRING IMBLMS	a) ONLY ONE MAN IS A SUBJECT DURING THIS PERIOD, SINCE HIS BUDDY IS SICK. THE OTHER NON-SCHEDULED CREWMEN FILL IN AS OBSERVER AND LAB TECHNICIAN. b) 1. IF SICK MAN NEEDS PHYSICIAN'S FREQUENT ATTENTION, CREW SHIFTS SCHEDULE SO THAT PHYSICIAN BECOMES SICK MAN'S BUDDY. 2. IF SICK MAN NEEDS CONTINUOUS ATTENTION FOR MORE THAN TWO (?) DAYS, REMAINING CREW MEMBERS CHANGE SHIFTS SO THAT BUDDY CAN PARTICIPATE IN MEDICAL EXPERIMENTS AND BE RELIEVED OF MEDICAL WATCH.
II. ACTIONS AND FUNCTIONS : AGENTS : 1. SUBJECT (SUBJ.) 2. OBSERVER (OBS.) 3. REMAINING AVAILABLE CREW (CREW) 4. INTEGRATED MEDICAL AND BEHAVIORAL LABORATORY MEASUREMENT SYSTEM (IMBLMS) 5. MISSION CONTROL CENTER (MCC)	SUBJ. AND OBS. SET UP AND PERFORM EXPERIMENT OBS. USES IMBLMS AND LOG BOOK, VERIFYING PROPER RECORDING. IMBLMS RECORDS DATA ON TAPE AND PERFORMS COMPUTATIONS. MCC IS USED IN REAL-TIME ONLY IN CONTINGENCIES.	IMBLMS IN STANDBY	SUBJ. AND OBS. PERFORM TASKS, ONE SUITED MAN STANDS BY, FOURTH MAN TALKS WITH MCC, SUBJ., OBS., AND MONITORS LIFE-SUPPORT EQUIPMENT. MCC MONITORS ACTIVITIES AND SYSTEMS.	MEDICAL EXPERIMENTS TERMINATED DURING REPAIR OF IMBLMS. SAME ACTIVITIES AS "REPAIR" MODE OF "OPERATIONS AND MAINTENANCE" (O & M) SUBSEQUENCE.	SAME ACTIVITIES AS IN A, EXCEPT THAT NON-SCHEDULED CREW FUNCTIONS AS AN OBSERVER AND TECHNICIAN
III. INFORMATION FLOW : a) INFORMATION REQUIRED b) ACTIVE LINKS c) DATA PRODUCED : 1) FILM (TYPE, # FRAMES OR FEET, WEIGHT TO BE RETURNED QUARTERLY 2) TAPE (BIT RATES-MAX. SUSTAINED PEAK, AVG; SPECIAL DUMP REQUIREMENTS 3) REALTIME TRANSMISSION	a) 1. PHYSIOLOGICAL PARAMETERS AS REQUIRED BY BY THE EXPERIMENT a) 2. ENVIRONMENTAL PARAMETERS OF CABIN b) MCC-OWS c) 1. UP TO 30 LB. FILM MAGAZINE PER 30 DAYS OF FLIGHT c) 2. MAX. SUSTAINED BIT RATE = 100 KBS c) 3. OCCASIONAL ECG AND VOICE	NONE	a) MEDICAL DATA, VOICE COMMUNICATION, PHOTOGRAPHS, SUIT PARAMETERS. b) VOICE LINKS BETWEEN TWO EVA MEN (NOT INDIRECTLY THROUGH UMBILICALS CONNECTED TO SPACECRAFT), BETWEEN EACH EVA MAN AND OWS, AND BETWEEN OWS AND MCC. BIOMEDICAL DATA TO IMBLMS. c) FILM OF S/C EXTERIOR, METEOROID PLATES, MEDICAL SAMPLES FROM MEN, IMBLMS TAPE, REAL TIME TRANSMISSION, ETC.	AS IN O & M REPAIR MODE	AS IN MODE A
IV. RESOURCES REQUIRED : a) POWER b) OTHER (BESIDES ORDINARY CONSUMABLES)	a) 125 WATTS STANBY, 520 WATTS NOMINAL, 730-1300 WATTS PEAK (MAX. OF 1/3 OPERATING TIME) OPERATING TIME IS 10 HOURS/DAY b) NONE	a) 125 WATTS	a) 30 WATTS TO OPERATE PLSS b) O_2 CONSUMED : 0.7 LBS/HR. MAX.	AS IN O & M REPAIR MODE	AS IN MODE A
V. TRANSITIONS a) SCHEDULED (NOMINAL) b) UNSCHEDULED (CONTINGENCIES)	a) 1. WHEN EXPERIMENTS ARE FINISHED, GO TO MODE B 2. IF AN ASTRONAUT HAS BEEN IN EARTH ORBIT FOR X DAYS BEFORE THIS MISSION, HE NEEDS MORE MEDICAL EXPERIMENT TIME AS A SUBJECT AFTER THE FIRST X DAYS OF THIS MISSION. SEE TEXT b) 1. IF DECONDITIONING OR ILLNESS OCCURS, GO TO E 2. IF IMBLMS MALFUNCTIONS GO TO D	a) 1. GO TO A WHEN MEDICAL EXPERIMENTS ARE SCHEDULED 2. GO TO C WHEN EVA IS SCHEDULED	a) WHEN EVA IS FINISHED, GO TO MODE B. b) 1. IF LIFE-SUPPORT SYSTEM IS DAMAGED SLIGHTLY, STOP EVA TASKS AND INGRESS. 2. IF MAN IS INCAPACITATED, RESCUE HIM. 3. IF EVA MAN IS NEEDED FOR ACTIVITY INSIDE, STOP EVA TASKS AND INGRESS.	WHEN REPAIR IS VERIFIED, GO TO A OR B AS APPROPRIATE	a) UNSCHEDULED b) WHEN INCAPACITATED MAN IS CURED, TO A OR B AS APPROPRIATE

FIGURE 2 - BIOMEDICAL/BEHAVIORAL SUBSEQUENCE OF ACTIVITIES